Quantitative Analysis of Pulmonary Perfusion Using First Pass Perfusion Magnetic Resonance Imaging

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Background: Many pulmonary diseases affect pulmonary vasculature whether primarily or secondarily. In patients with advanced primary pulmonary hypertension pulmonary perfusion is marked reduced. Therefore quantitative pulmonary perfusion may be clinically useful in diagnosing pulmonary vascular abnormalities. In this study we investigated 2D dynamic contrast-enhanced magnetic resonance imaging (MRI) using a saturation recovery SSFP sequence to quantitatively analyze pulmonary perfusion in normal volunteers.

Methods: Eight volunteers (ages between 30 to 69 years, 6 males) were enrolled after IRB approval. Using a partial Fourier saturation recovery SSFP technique, first pass perfusion images were acquired on a 1.5 T Avanto scanner (Siemens, Malvern, PA). A voxel spatial resolution of 4×2.6×20 mm^3 was achieved in 3 parallel coronal slices in anterior, mid and posterior lung locations. After the injection of gadolinium gadopentetate (Gd) dimeglumine (Magnevist by Schering AG, Berlin, Germany) (0.005 mmol/kg) at 6ml/s dynamic images were acquired every heartbeat over 50 heartbeats using an acquisition time of 160 ms per slice. FOV was 45 to 50 cm. Images were analyzed using MASS software (Medis, Leiden, Netherlands). The contours of the left and right lung parenchyma were drawn manually and then propagated automatically at each time point with manual adjustment when necessary. Mean signal intensities of all pixels in both left and right lung of each time point were transferred to a proprietary deconvolution program. The absolute perfusion was then calculated using dynamic contrast signal in the pulmonary artery as input and that in the lungs as the distribution of tracer residence. A truncated singular value decomposition was used as a numerical deconvolution regularization technique with reduced matrix components to search for the optimized fit of the dynamic signal curves.

Results: As shown in the Figure below the dynamic signal intensity in the pulmonary artery (input function) and in the lung parenchyma was measured over 50 time points. Using low Gd dose the dynamic signal intensity was successfully measured in all 8 cases. Processing the time intensity relation yielded an absolute mean pulmonary perfusion of 228±142 ml/100ml/min in the right and 218±140 ml/100ml/min in the left lung (p=0.785). There was a graded increase in pulmonary perfusion from anterior to posterior regions in both lungs (Table). There was no difference between right and left lungs. Our quantitative perfusion values are comparable to the published results.

Conclusions: First pass perfusion MRI can be used to assess regional lung perfusion. A saturation recovery SSFP technique with 2D acquisition yielded adequate signal intensity in the lung parenchyma with Gd at 0.005 mmol/kg, allowing for optimal quantitative perfusion.analysis.

Figure First pass perfusion of the mid lung slice with areas of interest in colors showing the lung parenchyma and pulmonary artery at its peak contrast uptake (a) and corresponding time intensity curves in the same colors (b)

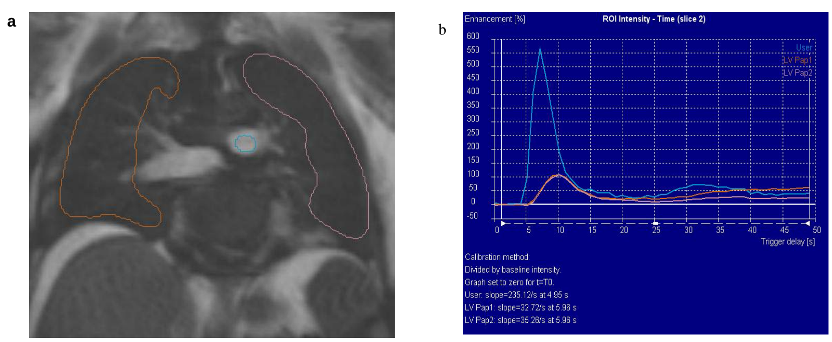

Table Differences in quantitative pulmonary perfusion in the anterior, mid and posterior slices

Location	**Right Lung (ml/100ml/min)**	**Left Lung (ml/100ml/min)**	**P value**
Anterior	131±48	138±74	0.842
Mid	179±66	163±60	0.622
Posterior	374±149	352±154	0.779
ANOVA	<0.001	0.001	